HOW to

Identify and Manage Needlecast Diseases on Balsam Fir

United States Department of Agriculture

Prepared by
Forest Service

Northeastern Area
State & Private Forestry

NA-FR-02-96

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This publication provides information on the general biology of balsam fir needlecast diseases and the characteristic features of diseased needles. Management recommendations to prevent needlecast disease problems are presented.

As an aid to diagnosticians, microscopic characteristics of each of three common needlecast fungi are presented in a table.

Cover Photo
Balsam fir foliage becomes tricolor after several years of infection by needlecast fungi.
Photo by Nancy Wenner

Introduction

Needlecast diseases are common in balsam fir stands and Christmas tree plantations in the northeastern and north central United States and in southern Ontario, Quebec, and New Brunswick. Three different needlecast fungi, *Lirula nervata, Lirula mirabilis and Isthmiella faullii,* cause similar disease symptoms on balsam fir. These diseases may affect other firs planted in the same stand, but will not affect Douglas-fir or other conifer species.

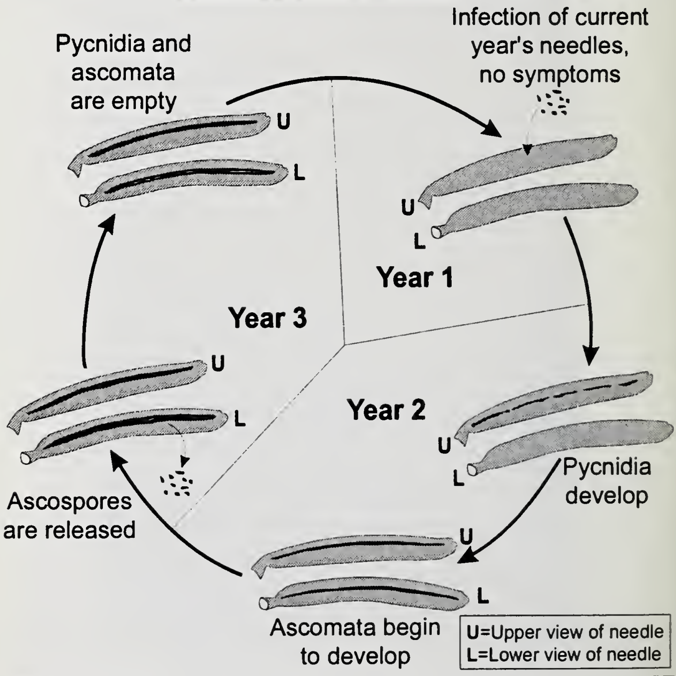
Injury from these pathogens ranges from scattered brown needles to the loss of most of the three- and four-year-old needles. Over a period of years, repeated and severe needle damage can reduce tree growth, cause bud and branch mortality on the lower portion of the tree, and even kill small seedlings. This damage decreases the quality of Christmas trees and makes boughs unusable for wreath-making.

Photo 1. Balsam fir needlecast disease in a Christmas tree plantation.

Biology and Symptoms

The three needlecast fungi on balsam fir all have a two-year life cycle and similar biology, including time of infection and symptom expression. Annual infection can result in distinctly tricolor foliage. The infected current-year foliage remains green, showing no symptoms until the following spring. The infected second-year foliage is brown, and the infected third-year foliage bleaches to a straw or tan color. Discolored needles may be shed or be broken off in the third year, or they may remain attached for a few years.

During the summer of the first year, fungal ascospores (microscopic spores) infect the current year's needles. Needles are infected individually and the fungus does not spread into the adjacent needles or the twig. The newly infected fir needles remain symptomless until the following spring when they begin to discolor. Infected needles then become pale and patchy green in color and slowly turn brown as they die. Pycnidia (fungal spore-producing structures) develop in the upper surface of these brown needles in late spring of the second year and mature during



Life cycle of *Lirula nervata*, typical of the needlecast fungi on balsam fir.

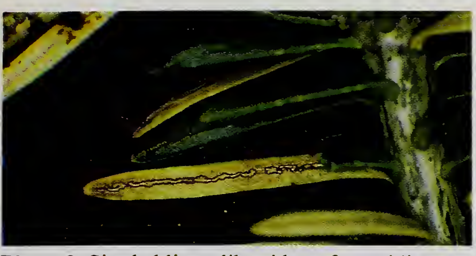


Photo 2. Single blister-like ridge of pycnidia of *Lirula nervata* on upper surface of needle. The ridge is similar in color to the needle prior to spore release, but darkens to nearly black after spore release.

Photo 3. Double ridge of pycnidia of *Lirula mirabilis* on the upper surface of needles. The pycnidia remain similar in color to the needle.

Photo 4. Variable width and shape of ridge of pycnidia of *Isthmiella faullii* on the upper surface of needles. The pycnidia remain similar in color to the needle.

summer. They appear as pustules or as blister-like ridges. The pycnidia vary in color, shape and placement according to the specific fungus involved, and their appearance can be used to distinguish among the three fungi (see photos 2-4).

The pycnidia produce tiny spores that are released during and following periods of wet weather, but these spores presumably do not infect fir needles.

In late summer of the second year, an ascoma (a second type of spore producing structure, *pl.*, ascomata) begins to form on the midrib in the lower surface of the needle. The ascoma will produce the infective spores called ascospores. The infected needles discolor further to a pale tan or straw color during the winter and spring months.

By the summer of the third year, the ascoma matures and looks like a dark line along the lower midrib. The darkness and width of the line vary slightly depending on which fungus it is. When mature, a slit forms along the length of the ascoma. During rain, the ascoma opens along the slit and ascospores are released. Discolored needles may be cast or broken off in the months following ascospore release, or the faded grey needles may remain attached for several years, but will not produce spores again.

Photo 5. Ascomata of *L.nervata* on underside of balsam fir needles. They are nearly black in color.

Photo 6. Closed (top) and open ascomata of *Lirula mirabilis* on the underside of needles.

Photo 7. Ascoma of *Isthmiella faullii*. It appears very similar to *Lirula mirabilis*.

Don't Confuse These With . . .

Many other fungi are often seen on balsam fir needles. These fungi often thrive and proliferate under the same moist, cool conditions as the needlecast fungi.

Rhizosphaera pini is a needle blight which differs significantly from the needlecast fungi in its fruiting structures, spores, and biology. Infected needles discolor and often hang downward on balsam fir branches.

Photo 8. Small black pycnidia of *R. pini* emerging from stomata of dead balsam fir needles.

Other fungi found on balsam fir needles may invade dead or weakened foliage. Some of these fungi effectively compete for foliar nutrients with the needlecast fungi and thus may inhibit the completion of the needlecast life cycle. The more commonly encountered balsam fir fungi are shown in photos 9-13:

Photo 9. *Phaeocryptus nudus* (arrow) on needle with *L. nervata.*

Photo 10. *Lophodermium lacerum* (arrows) on same needle with (and inhibiting fruiting of) *Lirula nervata.*

Photo 11. *Stegopezizella balsamae.*

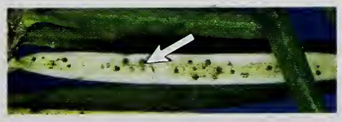


Photo 12. *Leptosphaeria faullii* (arrow) fruiting on needle with old *Lirula mirabilis* pycnidia.

Photo 13. Fir-fern needle rust, *Uredinopsis* sp.

Management

Varying levels of needlecast may be observed in forest grown stands and on intensively managed sites, such as Christmas tree plantations. Most injury occurs on small trees growing in cool, moist locations. Symptoms may be observed one to three years following a wet growing season. Damage is most evident on the lower branches (within four or five feet of the ground), where relative humidity is high and temperatures are lower. Disease is most prevalent in low-lying areas, shaded areas and areas where trees are crowded together. Areas where young balsam fir are surrounded by tall fir can be an ideal environment for high levels of disease. Young fir trees near windbreaks and trees adjacent to densely forested areas are commonly infected.

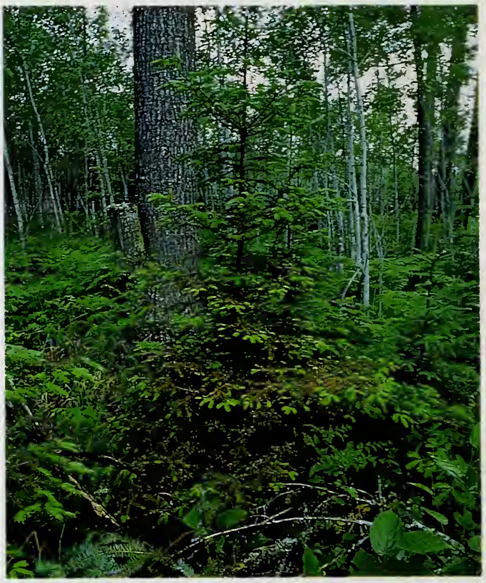


Photo 14. Needlecast disease on a forest-grown balsam fir seedling.

Control is usually not necessary because weather conditions and competition from other fungi keep the damage below serious levels. In wild stands, some disease may actually benefit the stand by serving to naturally "thin" the weaker seedlings and reduce overcrowding. However, in Christmas tree plantations, disease can cause economic loss. The necessity for control will depend on the level of disease which is present and the management objectives for the stand.

Disease *incidence* (the number of individual trees infected in your plantation) and disease *severity* (the amount of living tissue affected by the plant pathogen) are important pieces of information you will need to determine the level of action necessary to manage these pests. Severity can range from scattered tan needles to discoloration of nearly all older needles and needle loss. The best time of year to scout for this damage is winter and early spring. The cultural management techniques listed below should minimize disease. If you observe an increase in the incidence or severity, consider more aggressive disease management; contact your local forest health specialist for the latest management recommendations.

Cultural Techniques in Christmas Tree Plantations

❒ Do not grow balsam fir in areas where cool moist air collects and stagnates on a daily basis during the growing season. Locate plantations in areas where there is good air drainage.

❒ Carefully examine any native balsam fir for infected needles before planting. Do not introduce these diseases into your plantation by transplanting infected native balsam fir.

❒ Do not interplant balsam fir in infected portions of balsam fir plantations, as it tends to perpetuate the disease in the stand.

❒ Provide adequate space between trees, prune off lower branches and control weeds to allow more air flow.

❒ Do not leave live, infected branches on stumps of harvested Christmas trees; they serve as disease reservoirs.

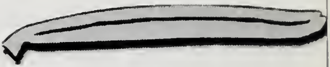
❒ Shear healthy plantations first so disease spores will not be carried into them from infected plantations.

❒ Do not shear infected foliage during wet weather because spores released at this time may be carried from tree to tree on shearing tools. Sterilize tools after shearing infected plantations by dipping in denatured alcohol for 3 minutes.

❒ If needlecast is a repeated and economic problem in your plantation, grow a species other than balsam fir.

Diagnostic Characteristics

The following table describes the characteristics which can be used by diagnosticians to distinguish among needlecast diseases on balsam fir.

<table>
<tr><th>When and Where to Look</th><th>Lirula nervata</th></tr>
<tr><td>By the summer of the second growing season, pycnidial ridges have formed on the upper needle surface.</td><td>
The single, raised pycnidial line distinguishes this species from the other two. It becomes black by late summer. The line may be continuous or interrupted. Conidia are produced in summer and are single-celled, hyaline, ovate, 4.5-6.0 x 1.0-1.2 µm</td></tr>
<tr><td>By the summer of the third growing season, an ascoma has formed on the lower needle midrib.</td><td>The black ascoma commonly is continuous along the midrib. Its width is 0.45 to 0.60 mm. Upon maturity the ascoma splits open revealing the hymenial layer which is pale yellow.

Asci are cylindrical to clavate, 8-spored, 130-208 x 17-27µm. Paraphyses are filiform, almost straight, hyaline, 120 x 1.5 µm, sometimes branching and cutting spore-like cells.

Photo 15. Ascus and ascospores.
Ascospores are filiform clavate, hyaline, 70-90 x 2.5-3.5 µm, and surrounded by a conspicuous gelatinous sheath 3-6 µm thick.

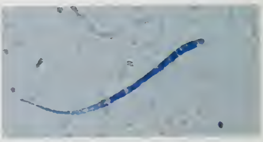



Photo 16. Ascospore.</td></tr>
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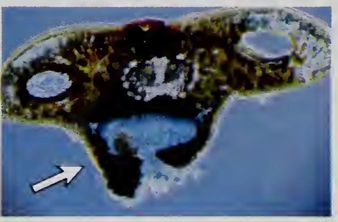
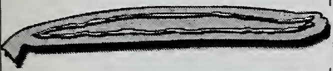
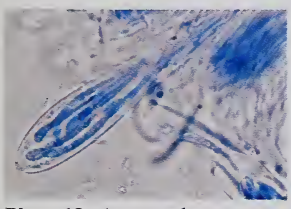
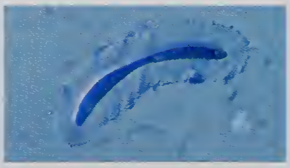
Photo 17. Cross section of needle showing asci in ascoma on lower surface (arrow) and remains of pycnidia on upper surface.



Lirula mirabilis	*Isthmiella faullii*
	
Pycnidia form in two raised lines, one on each wing of needle. Pycnidial lines are the same color as the needle tissue and may coalesce along the midrib. Conidia are produced in the summer and are bacillar, hyaline, 2.4-3.0 x 7.0-9.0 µm.	The heavy, labyrinthine or sinous pycnidial lines distinguish this species from the other two. It may appear as a single line or as two lines. The concolorous lines are variable in width. Conidia are hyaline, elliptical, 3.0-3.5 x 1.0-1.2 µm, and are exuded in effused masses or tendrils.
The red-brown ascoma is continuous along the midrib. Its width is 0.34 to 0.41 mm. The hymenial layer appears to be pale yellow once the ascoma splits open. Asci are broadly fusiform, 8-spored, 120-160 x 25-33 µm. Paraphyses are slender, filiform and about the same length as the asci.  **Photo 18.** Ascus and ascospores. Ascospores are cylindrical to clavate, tapering abruptly to an acute base, 65-85 x 6-7 µm with a gelatinous sheath 5-6 µm thick.	The dusky-brown ascoma is continuous along the midrib. Its width is 0.20-0.30 mm. The hymenial layer is orange-buff as the ascoma opens. Asci are clavate, truncate at the tip when young, 8-spored, 85-135 x 16-25 µm. Paraphyses are filiform, straight, 125 µm x 1µm.  **Photo 19.** Ascus and ascospores. Ascospores are double fusiform with slight constriction, hyaline, 45-55 x 5-6 µm, surrounded by a gelatinous sheath 3-5 µm thick.  **Photo 20.** Ascospore.

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Albers, M., J. Albers, J. Cummings Carlson, L. Haugen, and N. Wenner. 1996. Rhizosphaera Needle Disease of Fir. USDA-FS Pest Alert, Pub. No. NA-PR-06-96.

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Photo Credits:

Photo 1 by Jane Cummings Carlson
Photos 2, 3, 5, 6, 9, 15, 17, 18 by Linda Haugen
Photos 4, 7, 10, 11, 12, 13, 14, 16, 19, 20 by Nancy Wenner
Photo 8 by Steve Katovich